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ROTARY DRILLING IN ILLINOIS

BY

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Rotary Drilling in Illinois*

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To the end of 1937 over 20,000 oil wells have been drilled in Illinois, practically all of which have been drilled with churn-drill rigs. The first oil well in Illinois drilled by the rotary method was the discovery well of the Patoka field, completed in January, 1937. Since that date nearly all of the wells in the new fields of the State have been drilled with rotary rigs.

The churn-drill method works on the principle of percussion; a heavy steel bit attached to a manila rope or wire line is raised and dropped about 2 feet on the bottom of the hole to shatter and pulverize the rock. After drilling a few feet the tools are removed from the well and the sludge and cuttings are bailed from the bottom of the hole. The bailer is constructed of pipe, in the lower end of which is a valve that opens by the upward pressure of the fluid passed through as the bailer descends, and closes when the bailer is raised. After all of the cuttings are bailed from the hole the tools are again placed in the hole and drilling is resumed.

The churn-drill method was used by the Chinese centuries before the Christian era. It consisted of a bit suspended from one end of a horizontal cross-pole securely anchored at the other end. Coolies, jumping upon a platform connected to the free end of the cross-pole, provided the motive power for raising the tools which, descending by gravity, deepened the hole.[1] Later came the spring-pole drilling which was used until the latter part of the nineteenth century, and then the power driven churn-drill machines now used.

The first well in Illinois to be drilled by the rotary method was drilled by a portable rotary rig, which had the power and drilling machinery mounted on a large truck. Stationary rotary rigs soon made their appearance in the Patoka, Cisne, and Clay City fields. During 1937, 447 wells were drilled in Illinois and of this number, 285 were drilled with rotary rigs.

In rotary drilling the rock formations being drilled are chipped away by the grinding action of the rotating steel bit. The bit is attached to the bottom of a thick-walled pipe called the "drill stem". The "kelly" or "grief" stem is attached to the upper end of the drill pipe and extends upward through a square hole in the power driven rotary table. It is free to move vertically from a swivel and to rotate with the table while the upper part of the swivel and hoisting block remains stationary. The swivel, kelly stem, and drill stem are hollow, so that the drilling mud may be pumped under high pressure down to and out through holes in the bit. The stream of mud keeps the bit cool, washes the cuttings away from the cones, and carries them upward between the drill stem and the wall of the hole to the surface where they are allowed to settle out in "slush pits". After the cuttings have settled out, the mud is then pumped into the well again. This circulation is continuous as long as drilling is carried on. In addition to carrying the cuttings to the surface, the mud plasters the side of the hole and prevents caving. This is especially necessary while drilling in the Chester series in the Illinois basin. The Chester shales disintegrate when water touches them. In rotary drilling the face of the shale is mudded and does not cave. When drilling through the Chester shales with cable tools, frequently it is necessary to drill a few feet and lower the casing and drill some more in order to prevent serious caving of the hole.

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Drilling Mud. The physical properties of the mud used in drilling are varied according to the drilling conditions. If the hole caves, a specially prepared clay which forms a gel is added to the drilling mud to make it thicker, more effectively plastering the wall of the hole, so that it will stand up. In most wells drilled so far in Illinois, it has been necessary to use a special mud only to drill through the glacial drift to set the surface pipe. For the rest of the hole the formations drilled through usually contain an abundance of shale and the mud formed weighs from 8 to 10 pounds per gallon. In some wells in the Clay City and Noble fields special mud weighing 10.4 pounds per gallon is used in drilling from the Cypress sandstone to the McClosky sand. This especially heavy mud is used to prevent caving in the Paint Creek shales immediately below the Cypress. The Paint Creek shale causes more difficulty in drilling than any other Chester formation.

Fresh water is used in drilling and the mud remains fresh even though salt water formations are drilled through. As the pressure is very high, the mud enters the pore spaces in sands near the hole sealing off the salt water. Since salt water will flocculate the clay particles, it is important that the salt content of the mud be kept at a minimum.

Adequate Water Supply Necessary for Rotary Drilling. One of the big problems confronting rotary drilling, especially in the summer months, is an adequate water supply. The Diesel drilling rig uses from 500 to 700 barrels of water a day, while the steam rig uses from 800 to 1,400 barrels. It is usually necessary to pump water from a nearby creek or river to have a sufficient quantity of water to supply a number of drilling wells.

Drilling Time. The wells in the Clay City and Noble fields are drilled to a depth of about 3,000 feet. It usually requires from 18 to 21 days to drill a well in these fields to the McClosky "sand". The wells in the Centralia field are drilled in four or five days. The producing formation is the Benoist sand and is reached at a depth of about 1,350 feet. Usually sandstone drills the fastest, then porous limestone, shale and solid limestone in increasing difficulty.

The three-cone type of bit is used in drilling the wells. Each bit costs approximately $100. The average number of bits used in drilling a 3,000 foot hole in the Illinois basin is about 15. However, this number will vary with drilling conditions. In a recent test, drilled a little more than 4,000 feet deep to the St. Peter sandstone, 95 bits were used. The cherty formations of the Devonian system penetrated in this well were especially hard to drill.

The average cost of drilling in the new fields is about four dollars a foot. A completed oil well in the Clay City and Noble field costs from 20 to 25 thousand dollars. In the Centralia field it is from 8 to 9 thousand dollars; this includes the necessary equipment for producing the wells.

Comparison of casing programs for rotary and cable tools. It is necessary to case off the water sands before drilling deeper, using cable tools, because deeper oil sands may be flooded. The hydrostatic pressure of the column of water above the sand may be sufficiently high to force the oil back into the formation. In the discovery wells of the Cisne and Clay City fields a number of strings of casing were run in order to shut off salt water from sands passed through in drilling to the oil sand.

The amount of casing used in the discovery well of the Cisne field is as follows: 44 feet of 20-inch casing; 447 feet of 16-inch; 1,065 feet of 13-inch; 2,142 feet of 10¾-inch; 2,877 feet of 8⅝-inch; 2,942 feet of 5⅝-inch.

With rotary drilling only two strings of casing are used. In the Clay City and Noble fields, the well is drilled to a depth of about 200 feet and 10-inch casing is run to this depth and cemented. The well is then drilled to the bottom of the pay sand with open hole. If the well will make a producer, 7-inch casing is run to the top of the sand and cemented. After the cement has set and the concrete plug at the bottom of the hole has been drilled out, the well is usually acidized or shot with nitroglycerin if oil does not flow to the surface. This treatment makes a larger hole and increases the porosity in the sand. If the well then does not flow, a pumping unit which pumps the oil to the surface and into the storage tanks is installed.

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[1] Diehl, John C.—Natural Gas Handbook, published by the Metric Metal Works, Erie, Pennsylvania (1927), page 215.